Dynamical Systems, Neural Networks and Cortical Models **F49620-93-1-0522** (AASERT) 6. AUTHOR(S) Morris W. Hirsch 8. PERFORMING ORGANIZATION 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AEOSRIR 95 NUMBER 3 Center For Pure and Applied Mathematics University of California 1-443964-22537 Berkeley, CA 94720 10. SPONSORING / MONITORING 9. SPONSORING MONITORING AGENCY NAME(S) AND ADDRESS(ES) AGENCY REPORT NUMBER Air Force Office of Scientific Research/PKA 110 Duncan Avenue Suite B115 F49620-93-1-0522 Bolling Air Force Base, Washington, D.C. 20332-0001 (AASERT) 11. SUPPLEMENTARY NOTES 124. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution unlimited. 13. ABSTRACT (Maximum 200 words) Abstract Work was done on an oscillating neural network "computer" that could recognize sequences of characters of a grammar. It was extended to employ selective control of synchronization to direct the flow of communication and computation within the architecture to solve a grammatical inference problem. Because intercommunicating modules of the architecture are analytically guaranteed to store and recall multiple oscillatory and chaotic attractors, the architecture served as a framework in which to

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AASERT93/Dynamical Systems, Neural Networks, and Cortical Models

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1 Specific Progress

Work was done on an oscillating neural network "computer" that could recognize sequences of characters of a grammar. It was extended to employ selective control of synchronization to direct the flow of communication and computation within the architecture to solve a grammatical inference problem.

Because intercommunicating modules of the architecture are analytically guaranteed to store and recall multiple oscillatory and chaotic attractors, the architecture served as a framework in which to arrange and exploit the special capabilities dynamic attractors.

In this architecture, oscillation amplitude codes the information content or activity of a module (unit), whereas phase and frequency are used to "softwire" the network. Only synchronized modules communicate by exchanging amplitude information.

Chaotic attractors from the large family of Chua attractors were synchronized for operation in the architecture using techniques of coupling developed for secure "broadspectrum" communication by a modulated chaotic carrier wave.

The capabilities of this architecture were explored by application to the well studied problem of grammatical inference. Even though it is constructed from a system of continuous nonlinear ordinary differential equations, the system can operate as a discrete-time symbol processing architecture, but with analog input and oscillatory subsymbolic representations.

The architecture operates as a thirteen state finite automaton that generates the symbol strings of a Reber grammar. It was designed to demonstrate and study the following issues and principles of neural computation: (1) Sequential computation with coupled associative memories. (2) Computation with attractors for reliable operation in the presence of noise. (3) Discrete time and state symbol processing arising from continuum dynamics by bifurcations of attractors. (4) Attention as selective synchronization controling communication and temporal program flow. (5) chaotic dynamics in some network modules driving randomn choice of attractors in other network modules.

To advance intuition for theoretical analysis, interactive simulations of the network applications were designed on the SGI 4D35G Personal Iris Graphics Workstation. These allowed real time graphic display of network dynamics and learning as parameters were varied.